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Homeward bound: post-translocation homing behaviour of an Angolan giraffe in Namibia

J Fennessy[1,2], MB Brown[1], P Ekandjo[1], S Fennessy[1], S Ferguson[1], L Tindall[3], M Tindall[3], CJ Marneweck[1]

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[1] Giraffe Conservation Foundation, Windhoek, Namibia. julian@giraffeconservation.org
[2] School of Biology and Environmental Science, University College Dublin, Ireland.
[3] ProNamib Nature Reserve, Maltahöhe, Namibia.

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Abstract

Measuring the short- and long-term success of a translocation is challenging but critical. With increasing artificial movements of wildlife within and between African countries, understanding the results of such translocations is valuable. Translocations are an increasingly common conservation management tool to reverse biodiversity loss through re-populating, augmenting and/or expanding populations, especially for giraffe (*Giraffa* spp.). In southern Namibia, we used GPS satellite tags to monitor the movement of six Angolan giraffe (*G. giraffa angolensis*) post-translocation. We report the first known 'homing behaviour' of a giraffe post-translocation (155 days and 893.65 km). We hope our results will help guide future large-mammal translocation strategies. Decision making should be based on shared knowledge, and increasing our understanding of translocation efforts is key.

Keywords: fences, Giraffa, giraffe, home range, homing, movement, Namibia, translocation

Introduction

Animal movement is a fundamental driver of evolutionary and ecological processes (Berdahl *et al*. 2018). Some species have a 'built-in' homing behaviour which researchers have studied for almost a century, in predominantly smaller terrestrial vertebrate species – both domesticated and non-domesticated (e.g. Leuthold 1966; Dell'Ariccia *et al*. 2008; Berdahl *et al*. 2016). More recently, increased attention has been given to homing behaviour, including that of African carnivores and eutherians.

For conservation management, it is crucial to understand whether animals 'return home' following translocations or introductions and why. Are such movements random, a result of navigation, or guided by a sense of familiarity? Additionally, it is useful to consider the possible roles of olfaction (familiar odours, scent gradients) and acoustic aid orientation in influencing these homing behaviours (Jorge 2011).

In Africa, homing behaviour has been reported in Ugandan kob (*Kobus kob thomasi*) males after a translocation of 5-23 km to a new area (Leuthold 1966), in both sexes of African savanna elephant (*Loxodonta africana*) after moves of up to > 150 km (Pinter-Woolman 2009; Fernando *et al*. 2012; Goldenburg *et al*. 2019), and in various large African predators including cheetah (*Acinonyx jubatus*), leopard (*Panthera pardus*), and lion (*Panthera leo*, e.g. Linnell 1997; Weise 2016).

Historically, homing studies have often been limited to capture-recapture events (e.g. Leuthold 1966; Dell'Ariccia *et al*. 2008; Berdahl *et al*. 2016). However, the use of GPS satellite technology has provided a better understanding of exact movements and has helped to assess if the homing behaviour was truly navigational (direct) or somewhat random (e.g. Marneweck *et al*. 2023). A high percentage of herbivores are reported to settle near release sites in unfamiliar ranges which would indicate a poor homing ability (Rogers 1988). However, where larger numbers of animals were translocated, this has not always been the case (Rogers 1988).

Red deer (*Cervus elaphus*) homed over relatively short distances when moved up to 11 km, with 88% of translocations resulting in successful homing, with a median time of 4.75 days (range 1.23–100 days, Silovsky *et al*. 2024). In 2008, Hartmann's mountain zebra (*Equus zebra hartmannae*) were translocated approximately 300 km (direct line) to a communal conservancy in northwest Namibia, and within a week returned to the capture site with the GPS satellite collar recording an almost direct navigational movement (Jago pers. com. 2024). On the other hand, for cheetah that were translocated > 137 km away from their capture site, no homing behaviour was observed (Weise 2016).

Whilst spatial movements of large non-migratory African mammals have been subjected to far fewer experimental investigations, largely for practical reasons, aspects such as partial and seasonal migrations have been reported. In ungulates, including giraffe (*Giraffa* spp.), such migrations are not uncommon within ecologically distinct seasonal ranges, whilst other animals in the population remain resident (Brown & Bolger 2020). Seasonal long-distance movement and non-migratory movements have been reported in various giraffe taxa, including the Angolan (*G. giraffa angolensis*, Fennessy 2009; Flanagan *et al*. 2016), Masai (*G. tippelskirchi*, Pellew 1984), Nubian (*G. c. camelopardalis*, Brown & Bolger

2020), and West African giraffe (*G. c. peralta*, Le Pendu & Ciofolo 1999). However, no systematic investigation into how giraffe navigate at both individual and population levels has been conducted so far.

Species translocations are a valuable and increasingly common conservation management tool used to reverse biodiversity loss through re-establishing, augmenting and/or expanding populations. Most translocations aim to establish viable populations at the release site (Fischer & Lindenmayer 2000) or permanently remove animals from the source site (Richard-Hansen *et al*. 2000). However, failures have been reported (e.g. Linnell *et al*. 1997; Fischer & Lindenmayer 2000; Massei *et al*. 2010; Fontúrbel & Simonetti 2011). One such impediment to success is post-release hyper-dispersal, which is the long-distance movement of individuals post-translocation (any direction) rather than homing to their original location. Bilby and Moseby (2024) reviewed 151 conservation translocations (reinforcements and reintroductions) with hyper-dispersal reported in 52.1% of them. Interestingly, hyper-dispersal was relatively consistent across taxa (42.9–60%), with eutherians exhibiting a higher average incidence.

In the case of giraffe, deliberate conservation translocations continue to benefit all four species across their range by re-establishing populations in areas where they were formerly extirpated and augmenting small, dwindling populations (e.g. Flangan *et al*. 2016; Brown *et al*. 2023). Therefore, putting this into context, it is critical to monitor the post-translocation movement patterns of wild giraffe to ensure they settle as much as to observe if they exhibit any unconventional behaviour. In the long-term, such monitoring will help assess and improve translocation tools in a species or population's conservation. This report highlights recent observations of a female Angolan giraffe which exhibited homing behaviour in southern Namibia. This is the first time such behaviour has been reported.

Study Area and Methods

Since its conversion from livestock farming, the ProNamib Nature Reserve (PNNR) in southwestern Namibia has sought to aid the restoration of wildlife habitat and migratory routes. The initial rehabilitation included the removal of fences and the re-introduction of Angolan giraffe to the territory (Zazapamue 2023).

On 26 April 2022, six sub-adult Angolan giraffe (3 females, 3 males) were individually captured on Farm Nomtsas (FN) in southern Namibia by chemical immobilisation with a combination of the ultra-potent opioids etorphine and thiafentanil (Fennessy *et al.* 2022). The opioids were immediately reversed with the full antagonist naltrexone, when the giraffe were in lateral recumbency. Once secured and stable, the giraffe were fitted with Ceres GPS satellite ear tags that were set to record four GPS coordinates per day to monitor translocation success. The giraffe were subsequently loaded onto a game capture truck, transported ~165 km southwest by road to PNNR, and released the following morning (Figure 1).

We calculated the home range (50% and 95%) of each giraffe using adaptive Local Convex Hull (*a*-LoCoH) in the R package *adehabitatHR* (Calenge 2006). For each individual giraffe, the value of *a* was calculated as the largest distance between any two points. To calculate the net daily distance moved by each giraffe, we calculated the distance between two consecutive points using the Vincenty ellipsoid formula and summed for each day. For both above calculations, we used R version 4.2.1 (R Core Team 2022).

The homing behaviour was assessed using package Circular v.0.4-7 (Agostinelli & Lund 2013) in R by calculating bearing angles and distances between a subject's last known location and release location relative to the capture site. Bearing angles were adjusted to set an individual's 'home' direction (i.e. the original capture site) to 0°. All distances were normalised on a scale from zero to one, representing the distance between a subject's capture and release sites. Fies *et al*. (1987) considered that an animal was homing if it returned to its capture property or moved its entire translocation distance towards the capture location within 22.5° on either side of the true 'home' direction (Fies *et al*. 1987). In addition, successful homing was defined to include the animal returning to the capture site.

Results and Discussion

On average, the GPS satellite ear tags recorded 2.69 locations/day (Table 1). All but one of the translocated giraffe established their home ranges around the release site on PNNR. One female giraffe (GCF00935_0787) lost her ear tag tracking device soon after release, and as a result we were unable to calculate home range estimates for this individual.

For the giraffe that remained on the release site, the average daily movements varied between 3.61 and 8.50 km per day and the home ranges between 17.70 and 31.29 km^2 (Table 1). One of the female giraffe movements, Jinjeh (GCF00938_1123), were within this same range with an average of 6.34 km moved per day when travelling and 4.17 km per day once settled back at the original capture site. Her home range at the original capture site was estimated at 138.70 km^2. Similar variation in home ranges has been reported for all four giraffe species across their geographical distribution and habitat types (e.g. Flanagan *et al*. 2016; Brown *et al*. 2023). As PNNR is a fenced environment, giraffe display smaller home range sizes for such an arid environment, compared to giraffe in the open communal area of northwest Namibia, where some of the largest home ranges of all (> 1,900 km^2) have been reported (Fennessy 2009). Considering FN is

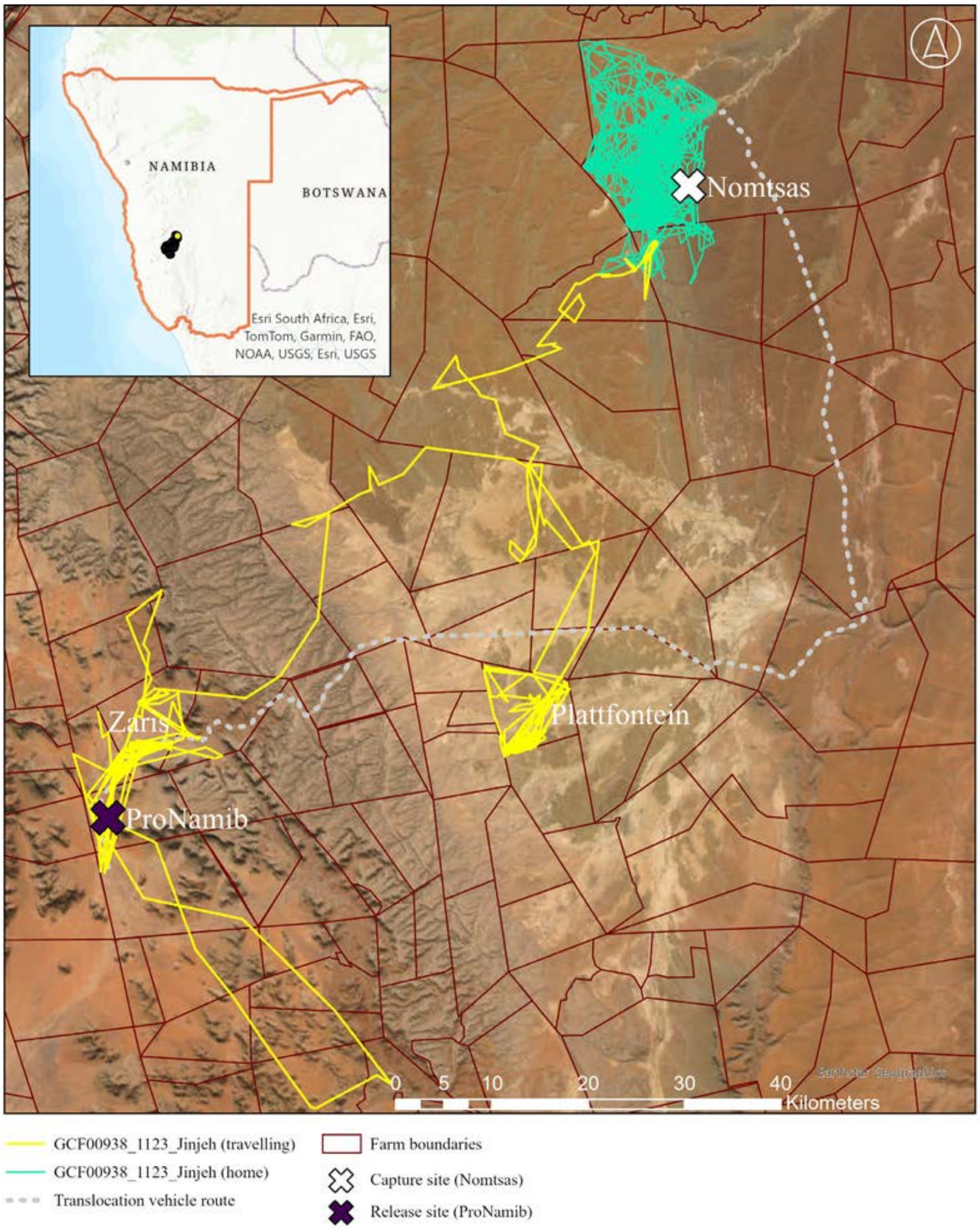

Figure 1: *The movements of a female Angolan giraffe GCF00938_1123_Jinjeh from the release site at ProNamib Nature Reserve (PNNR; purple 'X') returning home to the capture site (Farm Nomtsas; white 'X') between April and September 2022.*

Table 1: *Data summary, a-LoCoH home ranges and mean daily distance moved estimates of the GPS satellite tagged giraffe translocated to ProNamib Nature Reserve in 2022, including the female giraffe (GCF00938_1123_Jinjeh) who homed back to Farm Nomtsas (capture site), highlighted in bold.*

Giraffe ID	Sex	Tag start	Tag end	Days	Mean (± SE) locations/day	95% a-LoCoH (km^2)	50% a-LoCoH (km^2)	Mean (± SE) net daily km moved
GCF00823_0741_Landy	M	09/05/2022	22/04/2024	715*	3.15 (0.03)	23.37	4.16	4.43 (0.09)
GCF00853_1079_Fred	M	10/05/2022	22/04/2024	714*	2.69 (0.04)	21.66	3.64	4.14 (0.09)
GCF00935_0787_Verdane	F	27/04/2022	04/05/2022	7	2.33 (0.33)	-	-	8.50 (1.89)
GCF00937_1092_Genny	F	24/04/2022	26/06/2022	63	2.87 (0.14)	17.70	2.71	3.61 (0.32)
GCF00938_1123_Jinjeh	**F**	**09/05/2022**	**28/03/2024**	**690**	**2.77 (0.04)**	**138.70**	**23.17**	**6.34 (0.44); travelling 4.17 (0.11); home**
GCF00940_1235	M	09/05/2022	22/04/2024	715*	2.32 (0.03)	31.29	4.85	4.19 (0.11)

*denotes tag still active with the deployment end indicating the date of data extraction (22/04/2024).

200 km² and PNNR is 890 km², it is not surprising that Jinjeh's FN home range was larger than those that remained on PNN.

After the release of Jinjeh into PNNR on 26 April 2022, she immediately headed north. On 17 June 2022, after spending 52 days on the Zaris farm, Jinjeh started to move south again. Three days later she turned north and arrived back at PNNR on 23 June 2022. After a further ten days she left PNNR again and headed northeast before turning south. On 8 July 2022 she turned south and arrived at Plattfontein farm four days later where she stayed for 63 days. On 13 September 2022, she headed north again (along the same pathway that she arrived on), and on 19 September 2022 she turned northeast. On 28 September 2022, she arrived back on FN, where she was initially captured and where she has remained until today. Her ear tag fell off on 28 March 2024, and she cannot be tracked remotely anymore. However, personal observation using individual pelage coat pattern identification confirmed her current location on FN in June 2024. Ultimately, it took Jinjeh 155 days and 893.65 km to find her way back home. During her travels, she utilised various habitats, including riverine systems to the east of PNNR, along the escarpment, and moved further north-east of the escarpment.

Jinjeh did not exhibit homing behaviour as per the definition of Fies *et al*. (1987) i.e. moving the entire translocation distance towards the capture location within 22.5° on either side of the true 'home' direction. Of all 1,881 'steps' (i.e. a consecutive pair of coordinates), only four fitted the definition of homing (i.e. within 22.5° of home direction; 23:43:14 on 11/05/2022, 05:47:29 on 12/05/2022, 17:40:00 on 29/05/2022, and 21:49:20 on 04/06/2022). However, as she returned to the capture site, we do consider her behaviour as homing. Several natural and anthropogenic barriers exist in this landscape, such as fences, roads and the Khomas Hochland mountain range, all of which will have affected her route home. Despite this, she was still able to navigate the ~894 km journey (~155 km in a straight line). Interestingly, the homing behaviour of Jinjeh is the first time such behaviour has been reported for giraffe. It is unknown how she truly homed and what navigational senses were used. In homing pigeons, a single demonstration of a route is insufficient, with robust learning requiring repeated trips (Banks & Guilford 2000; Petit *et al*. 2013). The homing behaviour observed loosely fits the findings of Silovsky *et al*. (2024), who described an 'exploratory', then 'homing', and finally an 'arrival' phase. However, it was noted that the longer an animal needs to reach home, the more unlikely it is they ever enter an observed 'homing phase' – as observed by Jinjeh's movements which did not transition into a single fast and straight movement.

Gussett (2009) measured the short-term success of a translocation by the survival rate. Other than Jinjeh's return home, the translocation of Angolan giraffe was successful in the short-term, with all individuals surviving (Gussett 2009). However, due to the long gestation time of giraffe, the long-term success could not yet be established (i.e. in terms of both survival and reproduction; Gussett 2009).

Understanding and sharing findings like these can be valuable for conservation managers and researchers. They could help predict possible movements of translocated animals after their release and as such, inform the planning of future conservation interventions. From an applied management perspective, it is important to be realistic about possible outcomes of translocations and key to their success is the development of species- and site-specific translocation strategies. Moreover, assessing pros and cons of hard (immediate release) and soft releases (using a boma) should be further studied, while acknowledging that limitations for both methods exist. Decision-making in wildlife translocations should also be based on experience and situational knowledge, rather than purely on academic findings and assumptions.

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